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SOCIAL THEORETICAL INTERNATIONAL RELATIONS

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RESEARCH REPORT NO. 49

SOCIAL TIME AND INTERNATIONAL RELATIONS

R. J. Rummel

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SOCIAL TIME AND INTERNATIONAL RELATIONS

ABSTRACT

Time in our physical world is now a fourth dimension. It is considered relative and dependent upon the point of view of the observer. In our social world, time is subjective and also depends on the perspective of the observer.

In social science theorizing and empirical analysis, however, time is treated as an absolute continuum along which all events and entities existing at the same time have the same temporal status. This is true, for example, in all theoretical work in IR where the existence of an absolute calendar time is assumed. The purpose of this paper is to help alter the dependence on this singular view of time by incorporating in a field theory of international relations the notions of subjective (social) and multidimensional time.

In the representation developed here, time is treated as a set of dimensions which, along with social dimensions, describe the social space of nations. Attributes and behavior of nations have projections on these time dimensions contingent on a nation's change through calendar time. Nations are differently located on the time dimensions in terms of their relative magnitudes on the attributes related to time and their change in time on these attributes.

Social time in international relations is then represented as being dependent on the observer nation. In field theory terms, distances (for the same calendar time) between nation actor and object can be computed on the social time dimensions and treated as social forces affecting the behavior of one nation to another.

SCIENTIFIC REPRESENTATION

W. J. Rouse

What experience teaches us is that one method of representation is more appropriate than another in the sense that a map of the earth is more appropriate on the surface of the sphere than on a plane. The authority which we formerly attributed to the laws of nature in one way has now to be attributed in another to the logic of our method of representation, namely, in this way, that if we wish to make pictures of the world according to a particular scheme, then we must follow the rules of that scheme. This is not to say that the scheme determines what must be the form of the actual pictures we draw, but it does decide what pictures are possible Thus that we have called laws of nature are the laws of our methods of representing it. (Watson, 1966, p. 230)

I. INTRODUCTION

What is time? If anything seems to be assumed by students of international relations, it is that time has an objective meaning. Time can be calibrated. Events can be tagged as to their day, hour, and minute. And nations order their behavior in correspondence with a fixed, universally relevant, standard of time which has linear extension in the past, present, and future.

While time, thus partitioned, measured, and standardized, satisfies practical need and common sense, does this deeply ingrained orientation represent the only scientific reality -- the reality which is constrained and molded by our scientific frameworks and theories?

If asked about physical reality a century ago, this question would have been considered silly, at best. For in the Newtonian world view then permeating scientific theories and common sense perceptions alike, time and space were absolutes. Although the units were arbitrary, there was an underlying linear

reality -- a constant flow called time -- against which all change and motion could be gauged.

Still reeling from the fundamental and intellectually revolutionary construction of non-Euclidean geometries¹, a second fundamental blow was struck by Einstein at the beginning of this century by his theory of relativity. For Einstein, and for the contemporary natural sciences whose orientation towards time has been shaped by the theory of relativity, time is a fourth dimension of physical space. It is a coordinate axis which, along with the three axes of physical space, is subject to linear transformations. Time is not fixed, but relative to the motion of objects in space. More fundamentally, time is relevant to the observer.²

This fundamental break with the Newtonian world view was difficult for science to accept at first.³ The theory of relativity required two major transformations in thought, neither of which were easy by itself. First, the theory

¹ The development of non-Euclidean geometries proved that Euclidean geometry was not the only consistent geometry possible. It was clear that geometries that stand on equal mathematical footing with Euclidean geometry, while being contradictory to it, could be formulated. See Nagel (1961, Chapter 9).

² In the words of Gamow (1962, p. 88, italics omitted), "two events considered to be simultaneous from the point of view of one observer will from the point of view of another be separated by a certain time interval." Gamow provides a clear conceptual introduction to the theory of relativity and the role of space and time within it. On the philosophical implications of Einstein's treatment of time, see Grünbaum (1963). On the general philosophical implications, see Schilpp (1949) and Einstein (1954).

³ In the full meaning of the concept, the shift from Newtonian to Einsteinian theories was a change in incommensurable paradigms. The transformation of view involves literally a switch in visual gestalt from one world to the next. "In a sense that I am unable to explicate further, the proponents of competing paradigms practice their trades in different worlds. One contains constrained bodies that fall slowly, the other pendulums that repeat their motions again and again. In one, solutions are compounds, in the other mixtures. One is imbedded in a flat, the other in a curved, matrix of space. Practicing in different worlds, the two groups of scientists see different things when they look from the same point in the same direction." (Kuhn, 1962, p. 149).

was a change in conceptual orientation. New concepts were involved and old ones were seen in a different light.⁴

Second, and more basically, a shift in philosophical orientation was required. In the Newtonian sciences, there is a reality out there and this reality is described by our scientific knowledge and theories and the relationships in reality are given by our logic and mathematics. In the contemporary view, scientific theories are our reality and this is the only reality we are privileged to know. No matter how originally bizarre, scientific theories mold, shape and restrict our perceptions and become our reality, dependent upon their ability to encompass, order and predict observation.⁵ For the Newtonian mind, time was so

⁴ In nineteenth century physics, it was assumed that abstract symbols of the theory could be translated into observation. It was thought measurements could be made without difficulty. Einstein introduced descriptions--operational definitions --of how measurements would take place as "an essential part of the theory." (Frank, 1955, p. 20)

⁵ Einstein would not have completely agreed with this somewhat idealistic view. He would have gone so far as to say that theories are constructions of the mind. "Science is the attempt to make the chaotic diversity of our sense experience correspond to a logically uniform system of thought The sense-experiences are the given subject-matter. But the theory that shall interpret them is man-made." (Einstein, 1953, p. 253) But he would also assert that there is a reality which the theory should faithfully represent. "Some physicists, among them myself, can not believe that we must abandon, actually and forever, the idea of direct representation of physical reality in space and time" (Einstein, 1953, p. 261)

While Einstein himself thus kept one foot in the realist world, the realist philosophy was struck a fatal blow by the theory of relativity and later developments in quantum theory. With regard to relativity, for example, a characteristic of the theory is the "abandonment of mechanical analogies Instead, a logical empirical mode of expression is employed; that is, a system of mathematical formulae is given and the operations are described by which the magnitudes can be measured empirically." (Frank, 1947, p. 249) Mechanical analogies camouflage the analytic structure of theories. By blowing away this smoke screen -- this reality component -- theories could be seen as floating above the world of observations and connected to this world as dirigibles are connected to the ground by lines we call rules of correspondence. An excellent presentation of what I am calling the post-Newtonian perspective on science is given by Margenau (1950).

obviously an absolute part of physical reality that there was no doubt that events occurring at the same clock time occurred simultaneously, that time was universally the same for all things.

Oddly enough, while natural scientists, until recently, found it most difficult to believe physical time varied by observer, social scientists have long felt that time has a subjective component.⁶ The sense for the passage of time can vary for the observer and the activity.⁷ While I'm writing this paper, for example, time is moving with great speed; an hour is a fleeting minute and a page of scribbles. While sitting in a dentist's chair, however, each second of a minute has a palpable identity of its own; the memory of each minute is sculptured in enamel to be slowly eroded only by the passage of months.

Time not only varies subjectively but also culturally. Different cultures perceive and treat time in different ways (Hall, 1959).⁸ This is never more obvious than when moving from one culture to another, where standards of punctuality, where the value of time (such as the peculiar notion that time wasted is time lost)

⁶ See, for example, Hall (1959), Barker (1963), and Kluckhohn and Strodtbeck (1961).

⁷ "Within the human frame of reference, there are ... different institutionalized simultaneities Their differences are due to different units, if not exactly of measurement, than of perception.

"There are thus not only different lengths of present (however diffuse) in most human behavioral situations but there are also different layers of present" (Kolaja, 1969, pp. 8-9)

⁸ "It appears that what is considered in a culture as simultaneous is not only a variable, but in many instances a function of a number of persons or groups involved." (Kolaja, 1969, p. 15) For an historical study of mankind's reaction to time, see Brandon (1951).

and where the units of time vary. In spite of this relativistic view of social time (as distinct from the physical time of the natural scientists) to my knowledge, few social scientists have built this perspective into social theories.⁹ I know of no theory¹⁰ of international relations that has done so. Although, for example, many

⁹ Kurt Lewin's concepts of simultaneity and time perspective explicitly build relative time into his topological life space. By contemporaneity he means "that the behavior b at the time t is a function of the situation s at the time t only (s is meant to include both the person and his psychological environment),

$$b^t = F(s^t) ,$$

and not, in addition, a function of past or future situations s^{t-n} or s^{t+n} " (Lewin, 1964, p. 48) Then of the field existing at time t, Lewin later (p. 54) says, "It is important to realize that the psychological past and the psychological future are simultaneous parts of the psychological field existing at a given time t. The time perspective is continually changing. According to field theory, any type of behavior depends upon the total field, including the time perspective at that time, but not, in addition, upon any past or future field and its time perspective. See also Kolaja (1969) for another example of social theory using relative time.

¹⁰ By theory, I mean an interpreted analytic system of a logical or mathematical nature. The important thing is that the structure of the theory be explicit enough to enable checks on logical consistency, deductions, and disconfirmation of predictions deduced from the theory. This orientation towards theory is captured by Hempel (1952, p. 36) in the following: "A scientific theory might ... be likened to a complex spatial network: Its terms are represented by the knots, while the threads connecting the latter correspond, in part, to the definitions and, in part, to the fundamental and derivative hypotheses included in the theory. The whole system floats, as it were, above the plane of observation and is anchored to it by rules of interpretation. These might be viewed as strings which are not part of the network but link certain points of the latter with specific places in the plane of observation. By virtue of these interpretive connections, the network can function as a scientific theory: From certain observational data, we may ascend, via an interpretive string, to some point in the theoretical network, thence proceed, via definitions and hypotheses, to other points, from which another interpretive string permits a descent of the plane of observation."

I do not subscribe to the social science practice of calling theories those loose conglomerations of hypotheses and speculations that prevail in our field. How one moves from idea A to idea B in these speculations is often obscure; what can be deduced from within them or from them is unclear; and how these speculations would be subject to empirical test is unanswerable.

have posed that differences in social, racial or socio-political and economic distances affect national behavior, there is no suggestion that distances in social time are also relevant. The same calendar time for nations is accepted, theoretically and practically, as identical for all nations in describing their attributes and behavior and forecasting future international relations. It may be, to bring us to the point of this introduction, that time flows differently for each nation and that time in the international system is multidimensional.¹¹

This suggestion provokes problems which at first seem insurmountable. How can we relativize time as a part of social behavior. More specifically, how can we mathematically theorize time as a coordinate axis of social space? What does the notion of multidimensional time mean intuitively and mathematically within a social space? A vehicle for answering these questions is already found in the social field theory developed elsewhere (Rummel, 1965, 1969a, b).¹²

Field theory assumes that the behavior and attributes of nations have complex interrelationships and are constantly in flux. Moreover, behavior and attributes form a field of relationships--a gestalt, so to speak--such that to explain

¹¹ This view overlaps implicitly with the power transition theory of A. F. K. Organicki (1960, Chapter 12). For Organicki, international politics is a function of the ties that bind nations and the differential spread of industrialization. In the course of industrialization, nations go through stages in the development of their power and these stages represent different magnitudes and rates of change in power. At each point in time, therefore, Organicki is implying that nations are changing along different power-time paths and that nations will therefore behave, in part, in terms of their relative locations on these paths.

¹² A basic purpose of this paper is to elaborate on and extend the sixth axiom of field theory, which states that the direction and velocity of movement over time of a dyad in behavior space is along the resolution vector of the distance vectors between nations in attribute space. Since few readers can be expected to have a familiarity with the nature or perspective of field theory, the development of the axiom is being treated in a more general context.

behavior requires that the relationships between behavior and attributes need to be unraveled.¹³ These relationships are not seen as successive causal influences leading to an effect, but rather as a complex set of causes and effects, resulting in a particular effect through the total net itself.

Thus, the central idea here is a social space¹⁴ where in the infinitude of behaviors and attributes of actions there are vectors with extension and direction. This social space is like the physical space around us, except the social space defines the position of actions in their attributes and behavior.

At first view, this social space appears entirely as a mathematical abstraction,¹⁵ an interesting analytic toy of little use in understanding

¹³ This perspective is close to that of Levi (1964), who theorized that the behavior of individuals takes place in a life space. Levi's field theory overlaps at a number of points with theory being developed here, including the attempt to geometrize the social space. Tiselt (1955, Chapter 32) also develops a field theory, projecting actions as points into a multidimensional "analytic field." In both Levi's and Tiselt's developments, however, the social laws involved are not clear and the structure does not logically or mathematically hang together sufficiently for deductions or tests of their theories to be made.

¹⁴ Deussen and Lantley (1954) philosophically argued that social scientists should use the concepts of social space and dimensions to theorize about sociological phenomena in the same way that natural scientists had used the concept of space to deal abstractly with physical events. I consider Lantley to be an intellectual forerunner of the kind of theory discussed here.

¹⁵ For a careful and informed discussion of the role of abstractions in social theory, see Sheldon (1951). Unfortunately, Sheldon's essay is little known, but I would recommend it to complement Gurner's (1966) much referenced discussion of theory in the social sciences.

international relations. But those who are tempted to this view should realize that physical space is no less a mathematical abstraction.¹⁶ --an indispensable one to natural science. As a mathematical space, social space is defined by a set of dimensions in which the attributes and behaviors of nations are dependent. These dimensions span the social space and partition it into the linear independent interrelationships -- nets of causal influences and effects -- existing in social space.

For theoretical reasons, the social space can be divided into behavior and attribute subspaces.¹⁷ The former subspace comprises the behavior of dyads, such as the U. S. behavior towards West Germany, and each dyad has a projection on the

¹⁶ We take physical space so much for granted that it is hard to believe that it and motion within it (as it functions within scientific theory) are mathematical abstractions. On this, Butterfield's (1959, p. 34) comments are most pertinent. "The scientific revolution is most significant, and its achievements are the most remarkable, in the fields of astronomy and mechanics. In the former realm the use of experiment in any ordinary sense of the word can hardly be expected to have had any relevance. In regard to the latter we may recall what we observed when we were dealing with the problem of motion -- how it seemed reasonable to say that the great achievement was due to a transposition taking place in the mind of the inquirer himself. Here was a problem which only became manageable when in a certain sense it had been 'geometrised', so that motion had come to be envisioned as occurring in the emptiness of Archimedian space. Indeed, the modern law of inertia -- the modern picture of bodies continuing their motion in a straight line and away to infinity -- was hardly a thing which the human mind would ever reach by an experiment, or by any attempt to make observation more photographic, in any case. It depended on the trick of seeing a purely geometrical body sailing off into a kind of space which was empty and neutral -- utterly indifferent to what was happening -- like a blank sheet of paper, equally passive whether we draw on it a vertical or a horizontal line." See also Margenau (1950, pp. 127-128).

¹⁷ These are not linearly independent subspaces, such that the behavior subspace plus the attribute subspace equals social space. As will be seen later, the behavior subspace is imbedded in the attribute subspace. Mathematically, it would be correct to say that social space is attribute space and behavior is a subspace. For conceptual clarity at this stage of the discussion, however, I will treat attributes and behavior as subspaces.

dimensions of the subspace.¹⁸ These dimensions thus operate as coordinate axes defining the location of each dyad as a point in the space. All the possible dyads can be thought of as swarms of points through time, where each point has a definite position in a swarm relative to other points and each point has a projection on the behavior dimensions partitioning the interrelationships among the behaviors of nations.¹⁹

¹⁸ Although behavior in international relations is usually dyadic, theories and empirical research usually have been on monads, that is, the total behavior of nations. And research questions are asked monadically, such as what is the relationship between economic development and foreign behavior, between domestic and foreign conflict, and between democratic political systems and foreign policy. This dominant perspective, which I call attribute theory (Rummel, 1969a) is theoretically fruitful, but should not obscure the possibility of alternative and complementary formulations in terms of dyads.

A monadic perspective on behavior also governs social and psychological research. Sears (1951, p. 469), in trying to weaken this monadic dependence, argues that "if personality and social behavior are to be included in a single theory, the basic monadic unit of behavior must be expandable into a dyadic one. A dyadic unit is one that describes the combined actions of two or more persons. A dyadic unit is essential if there is to be any conceptualization of the relationships between people, as in the parent-child, teacher-pupil, husband-wife, or leader-follower instances. To have a science of interactive events, one must have variables and units of action that refer to such events. While it is possible to systematize some observations about individuals by using monadic units, the fact is that a large proportion of the properties of a person that compose his personality are originally formed in dyadic situations and are measurable only by reference to dyadic situations or symbolic representations of them. Thus, even a monadic description of a person's action makes use of dyadic variables in the form of social stimuli."

¹⁹ The concept of "behavior space" in field theory is similar in some respects to Tolman's psychological behavior space. In describing this space (1951, p. 297), he says that "a behavior space will contain not only particular objects but also their particular spatial and temporal, or other, relations to one another. Or, in other words, the "milieu" (i.e., the "directions" and "distances" constitutive of a behavior space) may be not only spatial and temporal, but also mechanical, aesthetic, mathematical, or the like."

Similarly, an attribute space²⁰ of nations can also be defined. This space would locate individual nations as points in terms of the projections of nations on the attribute dimensions. Since the dimensions of attribute space subsume all the variation among the attributes of nations, locating a nation on attribute dimensions is in effect locating it in terms of its similarities and differences from other nations.²¹

An immediate problem is how we should conceive of the origin of these spaces. Here, the assumption that behaviors and attributes are relative is central. It is not a nation's absolute attributes and behaviors that are important, but rather how his attributes and behaviors compare with others. In other words, the origin of behavior and attribute spaces should be relative to other nations: it should lie at the mean values of behaviors and attributes.

The assumption of relative attributes is also basic in another sense. The relative similarity and differences between nations affect their relative behavior toward each other. They act toward each other in terms of the similarity in economic development and political orientation, in terms of cultural and religious similarity, and in terms of racial and language similarity. At the individual level, this idea borders on common sense. Like marries like. Those sharing cultural and social traits tend to live close together. The poor behave differently toward the rich than they do toward others who are poor.

²⁰ From this point on, I will use the term space, with the understanding that for attributes and behavior we are considering subspaces.

²¹ For example, since height, width, and length are dimensions subsuming all the spatial measurements of boxes (such as volume, total surface area, and the area of any side), plotting boxes in the space of these three dimensions in effect locates boxes in terms of their spatial characteristics. The relative location of boxes, in this three-dimensional space, then, measures the similarities and differences among the boxes on these spatial characteristics.

The assumption that similarities and differences affect behavior is an old one in the social sciences. Much of this research has been done using the more precise term social distance,²² where those less alike in their attributes are considered more distant. With the exception of Quincy Wright (1942), the notion of social distance has not played much of a role in international relations theory until recently. Now, a great deal of attention is being given to rank theory, which postulates that interaction between nations is a result of their differential status (ranks) on social status variables in the international system. (Lagos, 1963; Galtung, 1964; Gleditsch, 1969)²³

Nations, as well as individuals, not only behave in terms of relative social distance but also as a consequence of their geographic distance from each other.²⁴

²² See, for example, Landis, Datrogler, and Dorn (1966), Parkman and Sawyer (1967), Priest and Sawyer (1967), Kerckhoff (1963), Glenn and Alston (1968), Laumann (1965) and Warner and DeFleur (1969).

²³ Rank theory as it is being developed under the stimulus of Johan Galtung and the International Peace Research Institute in Oslo overlaps with the theory that behavior is dependent on social distances. However, it is also mathematically different in a number of aspects resulting from their concern with absolute differences.

I think the concept of social distance is a direct link into the social status literature in international relations and also a bridge from this sociological perspective to the work of Deutsch et al. (1957), Wright (1942), and Russett (1967). At the sociological level, others have seen the connection between social distance and status. For example, Laumann (1965, p. 27) writes that the "focus upon the differential social interaction of various social classes or status strata as an important attribute of a stratification system immediately suggests the possible relevance of the concept of social distance for the analysis of such systems, inasmuch as the class structure is here being conceived in terms of the differential degree of social distance and resulting differential interaction being maintained among the various members of the community." As another example, Van Den Berghe (1960, p. 156) introduces his research on status by saying that the "central concept to be used here is that of distance as a mechanism of stratification. Some form of distance is presumably a functional prerequisite in any social situation involving authority, hierarchy, or stratification."

²⁴ For a bibliography of systematic studies employing geographic distance, see Olsson (1965). For a helpful discussion of geographic distance and international relations, see Wohlstetter (1968).

Nations that are contiguous will have a special salience compared to nations that are distant. The sharp impact of the Soviet Union setting up missiles in Cuba, some ninety miles from Florida, is still vivid in my mind as an example of this. It is not only how similar or different you are from another that is important, therefore, but also how physically close you are.

Distance, whether social or geographic, is a basic force in social systems at all levels and should have the status of a social law:²⁵ the relative behavior of social units toward each other is a function of their relative distances from each other.²⁶ The social space of nations, consequently, consists of a field of

²⁵ By social law, I mean a universal statement about social behavior unqualified as to time or place. In this definition, I disagree with Merton (1957, p. 96), who requires that such a law be derivable from theory. Laws can be derivable from theory, of course, but they also may be the axioms of a theory as in field theory and thus not derivable from it.

One source of misunderstanding of my definition may be the concept of universal statement. I am using this in the logical sense, where for simple statements there are three types: universal, particular, and singular. Thus, "all nations trade" is a universal statement which I would call a law. "Some nations trade" or "France trades" are statements that I would not call lawlike. Tying the definition of law into the classical analysis of statements thus enables the logical relations within a theory to be made clearer.

²⁶ Most, if not all, students of international relations will want to pose at least a few and probably many other factors affecting international behavior, such as perception, the personality of the leader, unique circumstances and events, topographical elements, nationalism, international organizations and law, strategic position, third nations, and the hallowed balance of power configuration. What I am doing is trying to reduce international relations to a fundamental abstraction -- a social law that holds, when other things are held constant. The law is an ideal, then, against which the deviation of observations can be given meaning. The effect of third nations on, for example, the behavior of the U.S. towards Egypt is considered as the effect of air resistance on motion. I am seeking the laws of motion, so to speak, and once found these other factors that are the favorites of students of international relations can be considered variables modifying predictions from the laws. Those who wish to read these other factors into the theory at the outset are, it appears, Baconian in their outlook on science.

For Francis Bacon, science was the accumulation of facts and generalization from them. He "missed the point of that kind of science which was to spring from Galileo [Bacon] regarded mathematics merely as the handmaid to physics, and actually complained of the dominion which it was beginning to exercise in that science. It was all very well to do sums on the results of one's experiments, but Bacon specifically disliked Galileo's method of turning the problem of motion ...

forces bringing about behavior. Social and geographic distances²⁷ between nations are the forces; the location in behavior space of a pair of nations (dyad) is a resolution vector of these forces. In field theory, this relationship is stated axiomatically as

$$U_{i \rightarrow j, k} = \sum_{\ell=1}^p \alpha_{\ell} d_{\ell, i-j} \quad (1)$$

where the term on the left is the projection of nation i's behavior to nation j on the kth dimension of behavior space and this is a linear combination of the weighted (by parameter α) combination of the distance vectors between i and j on the p dimensions of attribute space.²⁶ Since the origins of attribute and behavior spaces are at the means, equation (1) also incorporates the assumption of relative behavior and relative distances.

Given this brief sketch of a field theory orientation toward international relations, how are we to fit time into all this? Specifically, how are we to interpret and compute distances on social time dimensions? The following sections will deal geometrically and algebraically with these questions.

26(continued)

into the problem of geometrical bodies moving in geometrical space. Far from wanting to read away the air-resistance, in the way the new school of scientists were doing, he wanted to add other things to the picture--for example, the tensions that were bound to take place within the moving body itself."(Batterfield, 1959, p. 106)

In trying to reduce international relations to a fundamental force, I do not differ from traditional theorists. Hans Morgenthau's (1962) insistence on power as basic is well known; others, like Liska (1956) and Organski (1960) have also reduced international relations to either the interplay between power and norm or power and cooperative bonds between nations.

27 Geographic distance is not being added on here in an ad hoc manner. Geographic attributes are considered part of attribute space as discussed in footnote 42.

28 Kurt Lewin perceived his field theory in psychology to be a method. As he put it (1964, p. 45, italics omitted): "Field Theory is probably best characterized as a method; namely, a method of analyzing causal relations and of building scientific constructs." Field Theory as I have been developing in this paper and elsewhere (Rummel, 1969b) is more than a method. It is a theory of social behavior stating explicit relationships, as given in equation (1), between attributes and behavior; it is testable; it is falsifiable.

II. GEOMETRY OF SOCIAL TIME

To begin with, nations are conceived of as points in a social space defined by independent dimensions.²⁹ The behavior and attributes of nations are fully described by the projections nations have on the dimensions of social space. Social space itself can be theoretically divided into behavior and attribute spaces, within which nations and dyads are conceived of as vectors. Figure 1A and 1B show these spaces for three dimensions.³⁰ To illustrate how nations are located, only three nations are shown in attribute space and two dyads in behavior space. A label on a dimension represents the particular attributes or behavior most linearly dependent on the particular dimension.

These figures give the basic social picture involved in the notion of social space. An immediate question concerns the logic by which we arrive at this representation and the manner in which we can empirically define the dimensions and projections of nations and dyads. For what is the purpose of such a theoretical

²⁹ Because the geometry and mathematics of international relations to be introduced may be intuitively strange, at first, some may wish to use this lack of intuitive familiarity to argue against the theory. In defense I think Margenau's (1950, p. 150) comment suffices: "Lack of intuition is not a significant criterion of anything, for it can be acquired by training and has as wide a range of variability from person to person as has color vision."

³⁰ From the research done to date, these spaces for 1955 and 1963 appear to each have more than ten social dimensions, i.e., to be at least ten dimensional. Economic development, size (or power bases), and political orientation dimensions have been found to account for around forty percent of the variance in attributes among nations (Kummel, 1969c) for 1955 and about thirty percent for 1963.

The possibility of at least ten dimensions for social space may seem strange and absurd to those who are comfortable with four dimensions of physical space. This is not novel to science, however, such multidimensionality "is at least as old as Lagrange, who published his famous treatise on 'Mecanique analytique' in 1788, and there is nothing strange or inherently different in Gibb's theory of statistical mechanics, which operates with phase spaces of 10 dimensions and more." (Margenau, 1950, p. 1955)

ATTRIBUTE SPACE

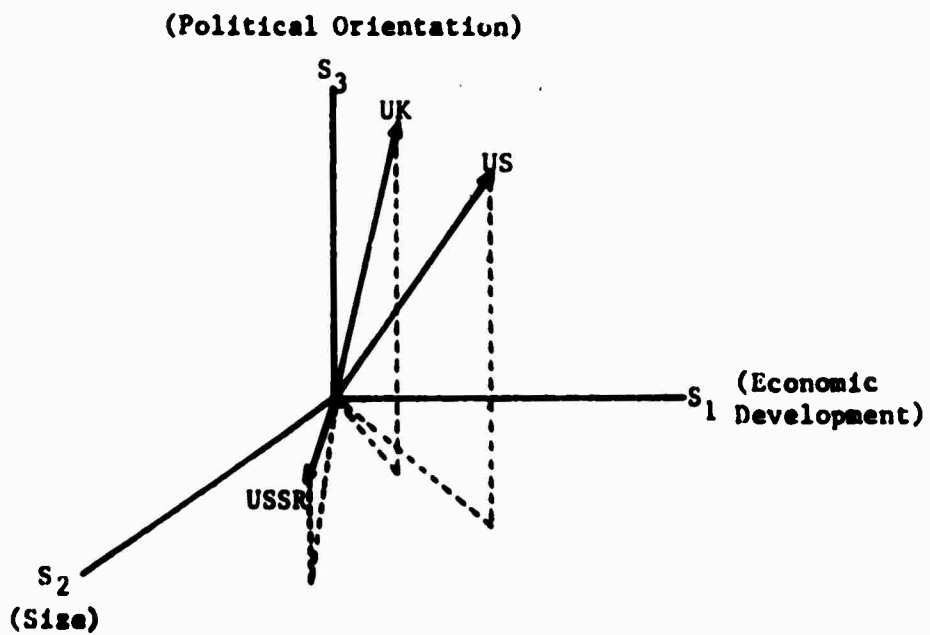


FIGURE 1A

BEHAVIOR SPACE

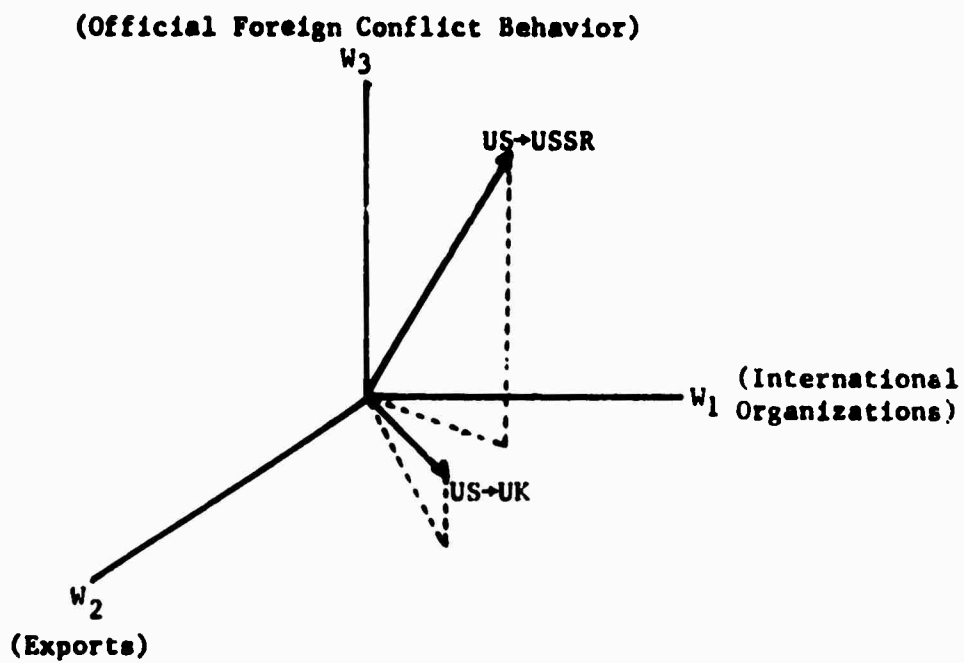


FIGURE 1B

representation if we cannot ultimately tie it down to observations.³¹ Let us, therefore, move back to some initial geometric and algebraic considerations and, keeping contact with observation, develop the interpretation of time hinted at in the introduction.³²

³¹ In developing field theory, I am explicitly trying to avoid the major deficit of mathematical theories and models in the social sciences. As Stauffer puts it (1957, p. 30), too "much of what passes for mathematical model building in the social sciences -- econometrics affords numerous examples -- seems to be an exercise in equation writing with little or no concern over the ways and means of relating the models to empirical phenomena." Unfortunately, the attempt to lodge field theory in the methods and data operations by which the theory can be related to observation has been a major source of misunderstanding. On the one hand, mathematical modelers accustomed to equations unencumbered by connections to techniques or observations see field theory as the development or elaboration of a methodology for handling data. On the other hand, empiricists used to applying various techniques to data see in field theory just another use of factor analysis to obtain dimensions of national attributes or behavior.

³² Some may wonder why I do not "operationalize" social distance and just do a time series analysis. The answer is simply that I do not believe that science makes great advances by such inductive procedures. A theoretical context -- framework -- must be given to guide the definition of facts and the analysis, as well as to interpret the meaning of the results. For example, with regard to the concept of inertia, Butterfield (1959, pp. 4-5) argues that "as writers have clearly pointed out, it is not relevant for us to argue that if the Aristotelians had merely watched the more carefully they would have changed their theory of inertia for the modern one -- changed over to the view that bodies tend to continue either at rest or in motion along a straight line until something intervenes to stop them or deflect their course. It was supremely difficult to escape from the Aristotelian doctrine by merely observing things more closely, especially if you had already started off on the wrong foot and were hampered beforehand with the whole system of interlocking Aristotelian ideas. In fact, the modern law of inertia is not the thing you would discover by mere photographic methods of observation -- it required a different kind of thinking-cap, a transposition in the mind of the scientist himself; for we do not actually see ordinary objects continuing their rectilinear motion in that kind of empty space which Aristotle said could not occur, and sailing away to that infinity which also he said could not possibly exist; and we do not in real life have perfectly spherical balls moving on perfectly smooth horizontal planes -- the trick lay in the fact that it occurred to Galileo to imagine these."

A theory allows us to imbed operationalized concepts (and attendant observables) in a mesh of unobservable abstractions that serve to explain observations. This aspect of theories has long been pointed out by historians and philosophers of science (such as Burtt, 1959, and Popper, 1965). Burtt's book was first published in 1932 and Popper's was first published in German in 1934) as well as scientists themselves (Einstein, 1954), but Hempel was one of the first to bring this before social scientists. In his words (1952, pp. 36-37), "the theoretical apparatus which

32(continued)

provides ... predictive and postdictive bridges from observations data to potential observational findings cannot, in general be formulated in terms of observables alone. The entire history of scientific endeavor appears to show that in our world comprehensive, simple, and dependable principles for the exploration and prediction of observable phenomena cannot be obtained by merely summarizing and inductively generalizing observational findings. A hypothetico-deductive-observational procedure is called for and is indeed followed in the more advanced branches of empirical science: Guided by his knowledge of observational data, the scientist has to invent a set of concepts -- theoretical constructs which lack immediate experiential significance, a system of hypotheses couched in terms of them, and an interpretation for the resulting theoretical network; and all this in a manner which will establish explanatory and predictive connections between the data of direct observation." Although widely referenced, it appears the impact of Hempel's analysis is little appreciated by behaviorists in international relations and the social sciences generally.

Unobservables aside, however, the faith in operationalization is so entrenched among behaviorists that it might well be emblazoned on the battle pennant leading the scientific movement in international relations. The charge "go forth, my son, and operationalize" is now such a graduation ritual that I cannot resist using Hempel (1952, p. 47) to lead another flank attack.

"In the contemporary methodological literature of psychology and the social sciences, the need for 'operational definitions' is often emphasized to the neglect of the requirement of systematic import, and occasionally the impression is given that the most promising way of furthering the growth of sociology as a scientific discipline is to create a large supply of 'operationally defined' terms of high determinacy and uniformity of usage, leaving it to subsequent research to discover whether these terms lend themselves to the formulation of fruitful theoretical principles. But concept formation in science cannot be separated from theoretical considerations; indeed, it is precisely the discovery of concept systems with theoretical import which advances scientific understanding; and such discovery requires scientific inventiveness and cannot be replaced by the -- certainly indispensable, but also definitely insufficient -- operationist or empiricist requirement of empirical import alone."

Consider a nT by N matrix of observations on n nations over T time periods for N attributes.³³ One of the columns of the matrix is a sequential time vector with all ones for the first time period, twos for all the second time periods, threes for all the third time periods, etc. The organization of this matrix is shown in Figure 2A. Figure 2B shows a similar matrix for behavior.³⁴ Note that while one

33 The matrix representation for social space and time relationships is selected purposely with an eye towards the philosophical and theoretical implications involved. Matrices are conceived of as linear operators -- as black boxes -- connecting the input and output of social phenomena. They bypass traditional social theory which "explains" behavior linkages in such terms as roles, norms, goals, institutions, and decision-making. Many of these presumed concepts and processes are being treated as unobservables -- as part of the unknown -- of social systems. On this conception of matrices, see Davis (1965, Chapter 7). On the philosophical perspective involved, see Altmavaara (Altmavaara and Markkunen, 1956). The philosophy here is the same as that involved in the use of a matrix representation in physics.

"It ... happens that the classical [physical] theory has recourse to the concepts of motion, position and velocities of electrons, while what experimental observations yield is wave lengths and intensities of the radiations emitted by manifolds of excited atoms. This would seem to show that the basic concepts of the theory are of no account for the final result. One may therefore be tempted to examine how far one could go if the classical model were to be abandoned. Now if one were to construct a theory of atomic behavior without invoking the assumed but unobservable electronic motions within the atom, one could hardly do without matrices and matrix algebra for the following reason.

"When we examine the pattern of radiation emitted by an aggregate of atoms -- and this is all that observation can do -- we may conceive of each radiation of one wave length as emanating from some single atom of the aggregate of atoms, and through it indirectly the state of the entire aggregate of atoms, may thus be described by a succession of numbers giving the characteristic wave length and intensity of each kind of radiation that the aggregate may possibly emit. Such a succession of numbers may be arranged as a matrix. A matrix: therefore is one way of describing the state of affairs prevailing within a manifold of atoms, if we wish to avoid reference to quantities which, like the position and velocity of an electron, are in principle unobservable." (Singh, 1959, pp. 166-167, italics added).

34 An identical matrix (excluding the time vector) is employed by Phillips (1969) to represent the social space of dynamic nation behavior in a theory of these dynamics. To Phillips, the behavior of a nation at time t to some other nation is a "function of the trends and oscillations about these trends in its past behavior" Thus, behavior begets behavior is the social law and it is abstractly idealized in a geometric setting similar to that of field theory.

Attribute Data Matrix X

		GDP	Population	Area	Defense Budget	Time Vector
t_1	Afghanistan					1
	Albania					1
	Burma					
	...					
t_2	Yugoslavia					1
	Afghanistan					2
	Albania					2
	Burma					
t_3	...					
	Yugoslavia					2
	Afghanistan					3
	Albania					3
t_T	Burma					
	...					
	Yugoslavia					3
	...					
t_T	Afghanistan					T
	Albania					T
	Burma					
	...					
t_T	Yugoslavia					T
	...					
	...					
	...					

FIGURE 2A

Behavior Data Matrix Y

		Threats	Exports	Students	Migrants	Time Vector
t_1	Afghanistan→Albania					1
	Afghanistan→Australia					1
	Afghanistan→Austria					
	⋮					
t_2	Yugoslavia→Yemen					1
	Afghanistan→Albania					2
	Afghanistan→Australia					2
	Afghanistan→Austria					
t_3	⋮					
	Yugoslavia→Yemen					2
	Afghanistan→Albania					3
	Afghanistan→Australia					3
t_T	Afghanistan→Austria					
	⋮					
	Yugoslavia→Yemen					3
	⋮					
t_T	Afghanistan→Albania					T
	Afghanistan→Australia					T
	Afghanistan→Austria					
	⋮					
t_T	Yugoslavia→Yemen					T
	⋮					
	⋮					
	⋮					

FIGURE 2B

matrix concerns only nations, the other deals with dyads. This is a fundamental distinction and enables the later representation of social distances as forces in social space.

The matrix X represents an attribute space of nations as pictured in Figure 3A. The nations for each time period are the initial coordinates of the space. Only three of these coordinates are shown in the Figure, but we can imagine (perhaps with a little difficulty) the number of coordinates being extended to all n nations times T periods. The attributes are vectors in this space with projections on the axes in terms of the attribute values for each period (such as the GNP for the U.S. in 1965). Time is also a vector in this space, with the relationship between the attributes and time being given by the cosine of the angles between the attribute vectors and the time vector, such as for angles θ and ϕ in Figure 3A.

Imbedding time as a vector in social space as done in Figure 3A is a key to later determining the social time dimensions of this space. By being part of social space, time has relationships with attributes (and behavior, as can be seen in Figure 3B) and it is precisely this relationship we want to delineate further. To measure the different location of nations on social time dimensions for the same calendar time, we first have to delimit this relationship of attributes to time.

Figure 3E illustrates the behavior space of matrix Y . In this case, the axes are for dyads for time periods and the vectors located in this space are for behavior. For the reasons mentioned above, time is also one of the vectors in this space.

What are the minimum dimensions necessary to define attribute and behavior spaces? That is, how can we transform the social spaces as viewed from the perspective of Figure 3 to that of Figure 1? Let us concentrate on the attribute space defined by observations X in answering this question, since the mathematics will be the same in both cases.

ATTRIBUTE SPACE X

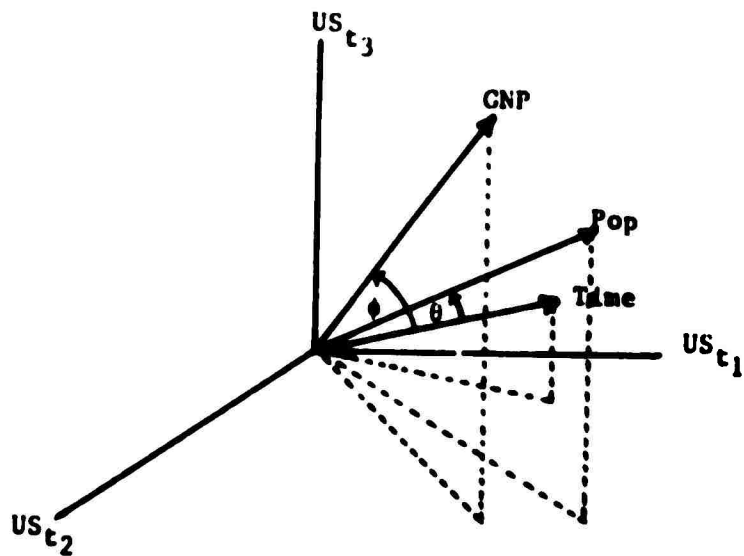


FIGURE 3A

BEHAVIOR SPACE Y

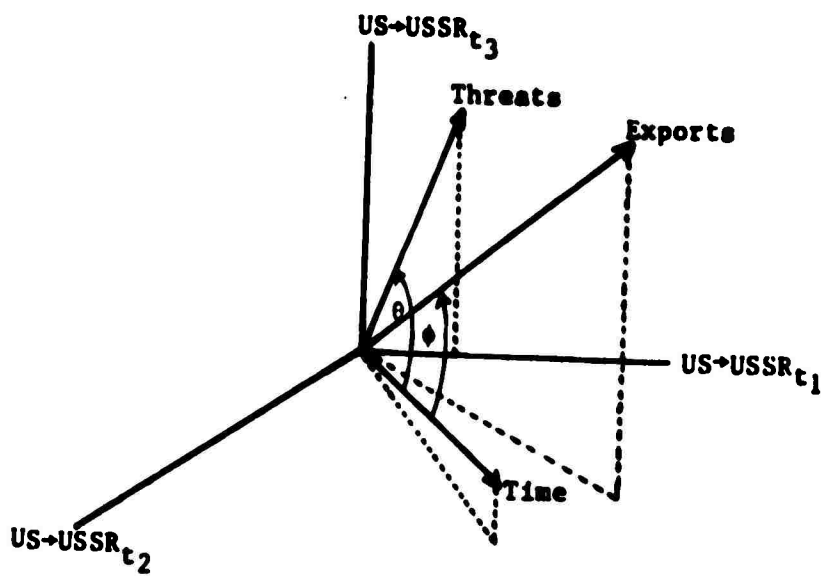


FIGURE 3B

First, assume that X is standardized by columns to a mean of zero and variance of 1.00.³⁵ This places the origin of the space at the mean, consonant with our desire that the space be concerned with relative values, and transforms all observations to comparable standard score units. Each of the attribute vectors will now have a length equal to the square root of the number of nations times the time periods. This standardization will also involve the time vector, so that our original units on the time vector are irrelevant within a linear transformation.

With X now standardized, we wish to define the orthogonal³⁶ attribute dimensions S upon which all the column vectors of X are linearly dependent. That is, we are after the attribute space dimensions upon which all nation attributes are dependent and which locate all nations in attribute space (like East-West and North-South dimensions locate all cities in the U.S.). More specifically,

$$X = SF, \quad (2)$$

where S is a $n \times p$ matrix, p is the minimum number of linearly independent dimensions necessary to determine X , and F is a p by M matrix of coefficients. These coefficients give each attribute vector of X as a linear combination of the dimensions (column vectors) of S . In the terminology of linear algebra, the column vectors of S are a basis of attribute space X . Given equation (2), the mathematical problem is to find S and F , when only X is known.

To begin, multiply (2) on the left by X' where the apostrophe will denote the transpose of the matrix to which it is attached).

$$X'X = X'SF.$$

³⁵ This standardization is accomplished by subtracting the column mean from each observation in that column and dividing by the standard deviation of the column elements.

³⁶ It is desirable for simplicity's sake that the social time dimensions form a right angle Cartesian coordinate system, which they will do if orthogonal. I am using orthogonal only to mean that the inner product of the dimensions (or two vectors) is zero. If I mean that the dimensions are also unit length, then I will use the more restrictive term orthonormal.

Then, using the equality of (2),

$$X'X = F'S'SF.$$

Recalling that X is standardized by column, multiply through by the scalar $1/nT$ to normalize all column vectors,

$$\frac{1}{nT} X'X = \frac{1}{nT} F'S'SF = F'(\frac{1}{nT} S'S)F.$$

Assume that the dimensions (column vectors) of S are standardized. Then,

$$\frac{1}{nT} S'S = I,$$

and,

$$\begin{aligned} (\frac{1}{nT}) X'X &= F'F, \\ R &= F'F, \end{aligned} \tag{3}$$

where F is a (product moment) correlation matrix for all the vectors in attribute space, as for example, the correlation between GNP and population in Figure 3A. Since we are treating the vectors in X as standardized, R also gives the cosines of the angle between the attribute vectors. The direction that attributes have in social space with regard to linear time is explicitly measured in R by the correlation of the time vector with the attributes of nations.

The problem of solving for S and F in (2) is now reduced to solving for F in (3), since R can be computed from a knowledge of X . From the properties of a correlation matrix, we know that R is symmetric and Gramian. We therefore know, also, that there is a similarity transformation of R such that

$$\begin{aligned} E^{-1}RE &= \lambda, \\ RE &= E\lambda, \\ R &= E\lambda E^{-1}. \end{aligned}$$

Define E as an orthonormal matrix of eigenvectors (by column) of R . Then λ is a

diagonal matrix of corresponding eigenvalues of λ , and

$$R = E\lambda E', \quad (4)$$

where the eigenvalues in the diagonal are ordered from high (in upper left) to low and the eigenvectors of E are ordered according to their eigenvalues in λ . An interesting and important aspect of E is that it gives the principal axes of the ellipsoid formed in the social space of attributes (and time) by the swarm of points representing all nations for all time periods (in R). The square root of the corresponding eigenvalues in λ then give the length of these principal axes.³⁷

The solution for F in (3) is now straightforward, where from (3) and (4),

$$R = E\lambda E' = (E\lambda^{1/2}) (\lambda^{1/2} E') = F'F \quad (5)$$

and,

$$F = (\lambda^{1/2} E'). \quad (6)$$

Matrix F defines the projection of attributes on the minimum social dimensions necessary to define this space. In particular, the matrix gives the direction cosines (which are also correlations) between the time vector and each of these attribute dimensions.³⁸ To illustrate, assume that in terms of the attributes most

³⁷ The reciprocals of the square roots of the eigenvalues are the lengths of the principal axes of the ellipsoid describing the quadratic form involving a symmetric matrix. However, in correlation theory it is the inverse of the correlation matrix involved in the quadratic form which determines the correlation ellipsoid. Thus, the reciprocals of the reciprocals of the square roots of the eigenvalues, which equal simply the square roots of the eigenvalues, are the lengths of the principal axes of concern to us.

³⁸ The solution in equation (6) is identical to the principal components (in factor analysis) of the correlation matrix. F would then be the factor loading matrix. See Harman (1967, Chapter 8).

The component analysis of the correlation matrix for the over time observation matrix laid out as in Figure 2A is sometimes called "super P-factor analysis."

In what follows I will ignore for simplicity of exposition the problems of the number of factors and the rotation of the initial dimensions to another solution. In practice, however, dimensions with eigenvalues greater or equal to unity would be extracted. Then, the additional dimensions on which time which has a nonzero projection would also be included (to assure the time vector is completely contained in the social space defined by the dimensions) and these dimensions rotated

highly dependent on the first two dimensions, we are able to label them economic development and power. Also assume that the time vector is fully contained³⁹ in the attribute space defined by these two dimensions, such that the remaining attribute dimensions are linearly independent of time. Figure 4 shows the hypothetical relationship of time to the two attribute dimensions of social space. The matrix F would give $\cos\theta$ and $\cos\phi$, where the angles are shown in the figure, and $\cos^2\theta + \cos^2\phi = 1.00$.

From the Figure, we can see that in attribute space, time as a social continuum is split into two linearly and statistically independent components. One of these components is related to the change in economic development of nations; the other to power growth. Nations, therefore, for the same calendar time can be progressing at different speeds and independently in their economic development and power. Moreover, and most importantly, these two dimensions can be defined as social time dimensions upon which nations will differ, depending on their differential growth and levels, for the same calendar time. We can therefore meaningfully measure nations in their social distance from each other on the social time dimensions for the same calendar time.

³⁸(continued)

to a simple structure (Harman, 1967, pp. 97-99) solution.

Factor analysis appears to be one of the most misunderstood and misused methods in the social sciences. Often it is mistakenly considered simply a statistical technique and the mathematical nature of factor analysis and its ability to structure theories is generally unknown. Yet, its theoretical pay-off is the method's greatest potential. In Ahmavaara's words (1958), "It is more illuminating to compare factor analysis with the differential calculus, which is widely used in physics and chemistry, than to compare it with the purely statistical analysis of variance, for instance. The factor theory is suggested to be a mathematical language for the consistent and unified expression of psychological and sociological theories, just as the differential calculus is a language for physical theories." (Ahmavaara, Yrjö and Markkanen, On The Unified Theory of Mind, p. 12).

³⁹ The vector would be fully contained if the sum of squared projections equal 1.00.

ATTRIBUTE SPACE

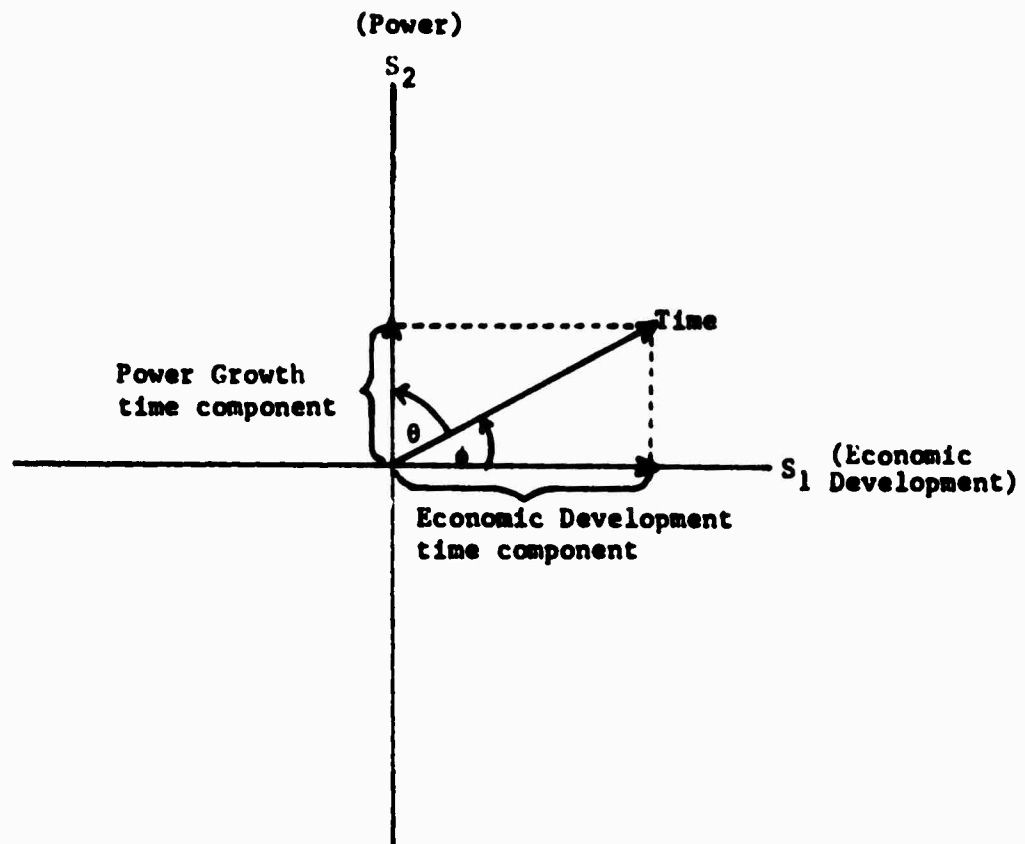


FIGURE 4

What then will be the projection of nations into this attribute space, and particularly on the social time dimensions? This can be determined by solving for matrix S in (2). Since we now know E , the following manipulations yield a solution to S :

$$\begin{aligned} X &= SE' \\ SE' &= SP' \\ SE'(E')^{-1} &= S \end{aligned} \tag{7}$$

S , which will be orthogonal by column, will then give explicitly the projections (standardized) of nations on the attribute dimensions of social space.⁴⁰ For example, S would give the location of nations for each time period on the dimensions of the space, as illustrated for just the U.S. in Figure 5. The projections in S for each nation for each time period thus enable an overtime plot of the change in attributes of a nation. Change is a circuitous movement through social space, where even when social time is taken into account, the movement may be quite curvilinear.

What S defines is the social space - social time movement of a nation as it changes, relative to other nations, on its many characteristics. This movement carves out a path in social space, such as in Figure 6, that may be measured, plotted, and most importantly related to the social time paths of other nations.

We can now raise one of the questions posed in the beginning. How are we to measure distances in social time for the same calendar time? Let us hypothesize again that we have two social time dimensions such as Economic Development and Power. Figure 7 shows hypothetical social time paths (from S) of the U.S. and U.S.S.R. on these two dimensions. For simplicity, both nations for each calendar time period t is treated as a point. Both nations have different social time

⁴⁰ Matrix S is often called the component (or factor) score matrix.

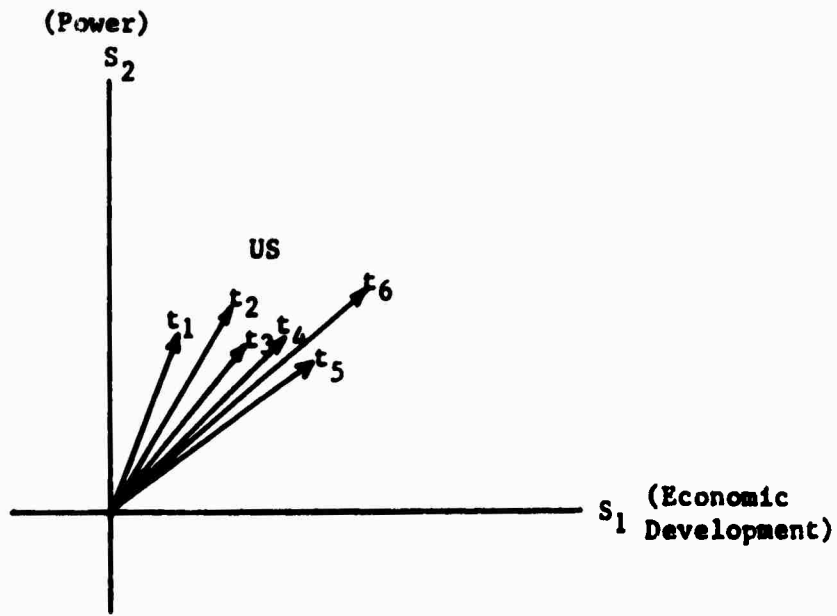


FIGURE 5

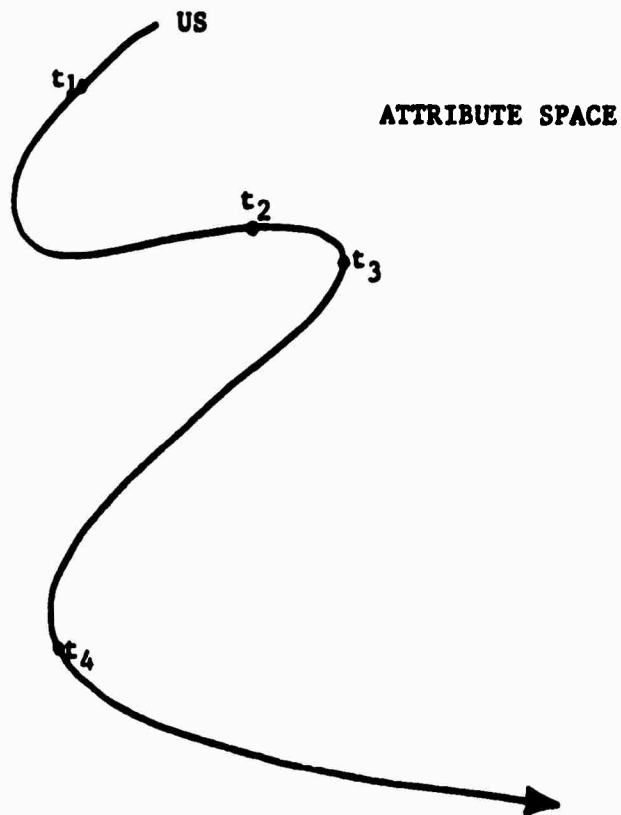


FIGURE 6

ATTRIBUTE SPACE

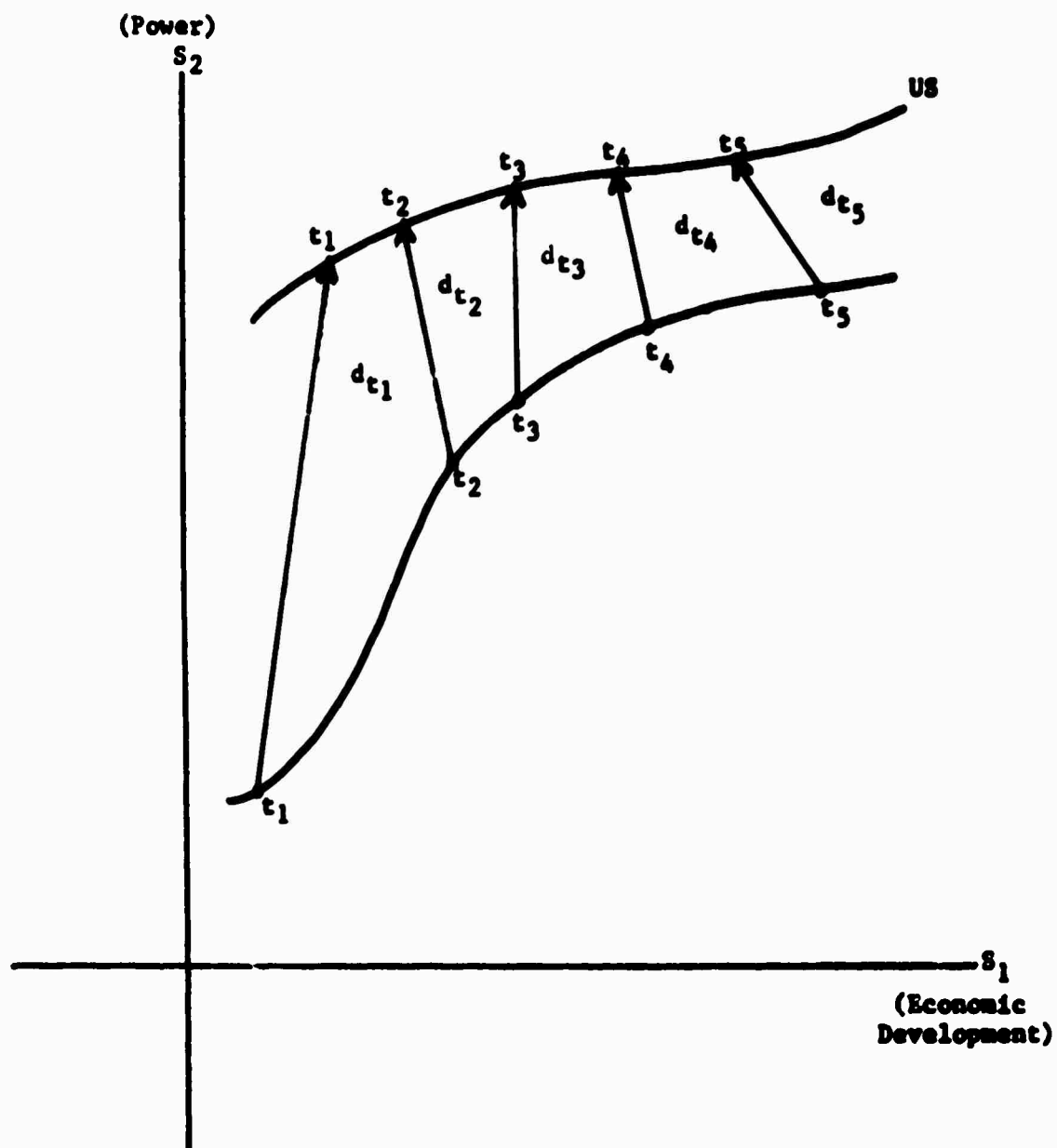


FIGURE 7

curves and the distance vectors, d_{t_1} , d_{t_2} , etc., indicate the magnitude and direction of the distance between the US and USSR for each of these calendar periods. Note that if we were only concerned with the distance in calendar time between the US and USSR, it would always be zero; calendar time for both would be the same. However, when we treat time as a social dimension, nations can now be differently located in social time for the same calendar time and in relation to all other nations.⁴¹

Similarly for behavior space, matrix Y can be analyzed as was X to yield behavior space and time dimensions of social space. Nations are coupled together in this space in actor-object pairs called dyads and each dyad has a life path through this space. The location and movement of a dyad in this path is a consequence of the social forces acting upon it, specifically the magnitude and direction of the distance vectors between actor and object at each time t.

Figure 8 illustrates behavior space for two hypothetical behavior time dimensions. A hypothetical life path for US-USSR behavior in social space is shown, with the distances from Figure 7 acting as forces on this movement.

The theoretical linkage between the behavioral life path and that of nations through attribute space is given by

$$w_{i+j,k,t} = \sum_{l=1}^p \alpha_{il} d_{l,i-j,t} \quad (8)$$

where k is a dimension of behavior space and w_{i+j} a projection on this dimension, t is a particular calendar time, d_l is the distance vector between i and j on the lth attribute dimension, and α is a space time parameter for a specific actor i. It

⁴¹ Let i and j be row vectors for nations i and j from the matrix S. Then the distance vector between nations i and j in the space of the social space and time dimensions is simply i-j. Each component of this distance vector will give a projection on one of the social space and time dimensions.

BEHAVIOR SPACE

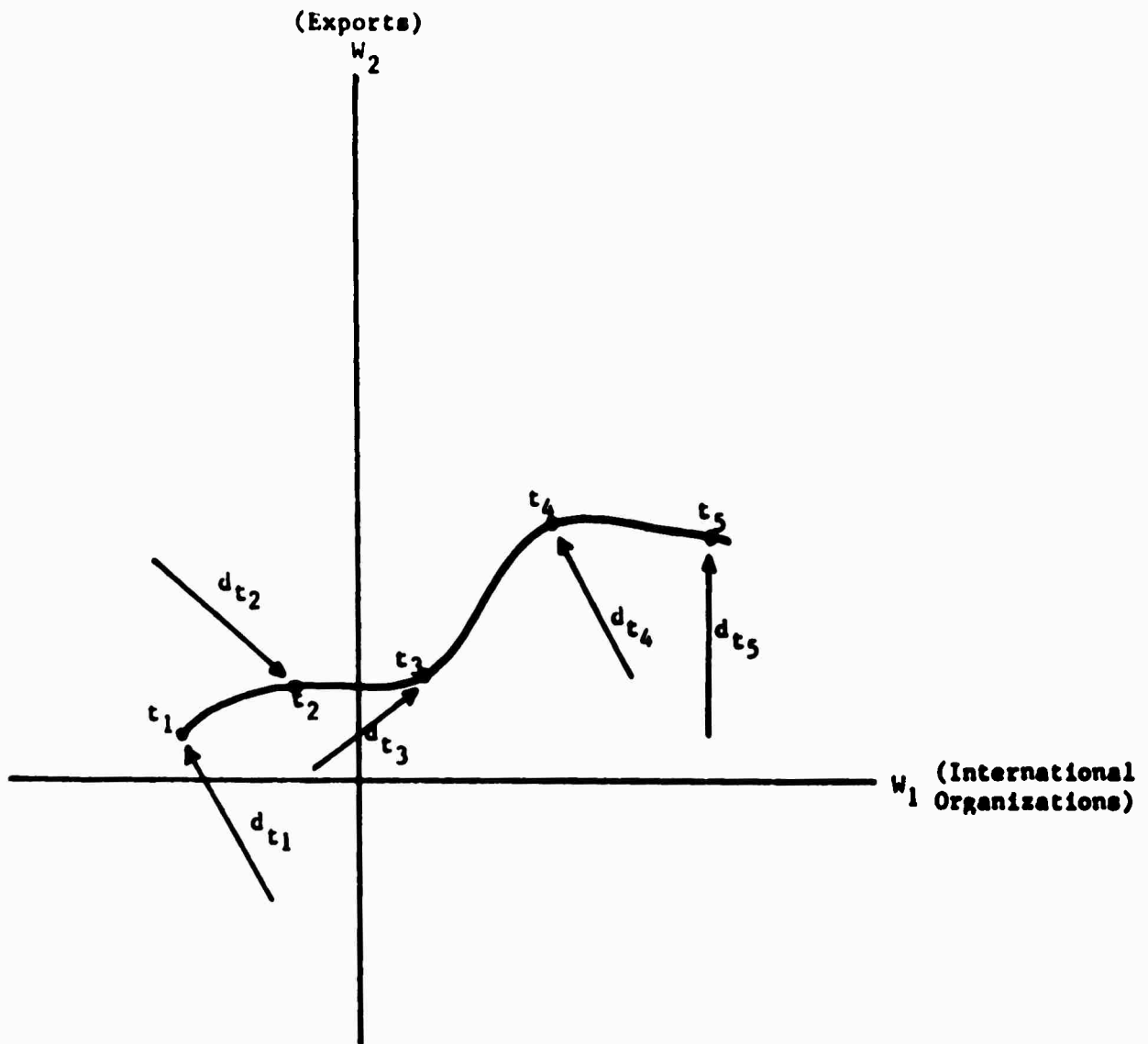


FIGURE 8

should be recalled that the dimensions upon which the social distances are calculated involve those independent of time as well as the social time dimensions discussed previously. Moreover, geographic dimensions are assumed to be part of this social space⁴² and therefore the social distance vectors reflect also the geographic distance between nations.

How can the space time parameters in (8) be evaluated? This is part of a larger question, which concerns the testing of the whole representation of social space and time involved here. Equation (8) can be put in the following matrix form,

$$WE = DA + e, \quad (9)$$

where W is a matrix of projections of dyads involving the same actor i on each of the behavior and time dimensions (by column) of behavior space, D is a matrix of distances (differences) between nations on the attribute and time dimensions of attribute space, A is the matrix of space-time parameters, and B is a transformation matrix. B rotates the dimensions of W such that the first rotated behavior dimension has the maximum correlation with a linear combination of distances, the second behavior dimension has the maximum residual correlation, and so on. The matrix e represents error of fit between behavior and attribute space and should be minimized, in a least squares sense, in solving for A and B in (9). Equation (9) is then the canonical model (Hooper, 1959),⁴³ and canonical analysis can be employed

⁴² Geographic distance is incorporated into attribute space by including as attributes of nations in matrix X three variables uniquely defining the geographic location of each nation's capital on the globe. The attribute dimensions of X then incorporate variance associated with geographic location and social distances on these dimensions reflect geographic distances between nations and the relationship of location with other attributes.

⁴³ See Rummel (1969b) for a more explicit development of the canonical model in the context of field theory and for the application of this model to testing field theory.

to evaluate the parameters A and to determine the correlation between behavior and attribute spaces over time according to equation (8). This correlation (called the trace correlation in canonical analysis) serves as a test of the theory developed here.

A virtue of the canonical model in linking behavior to distances over time is that behavior time dimensions and attribute time dimensions can be linked in terms of the overall relationship between behavior and attribute distances. The result will describe how the different growth on, say power and economic development, of nations relates to their relative growth in activity toward each other.

III. IMPLICATIONS

The discussion in the last section presents logically the perspective on social space and time sketched in the introduction. In the remainder of this paper, I will try to draw out some of the implications of this view.

Nations exist in a social space, whose origin reflects the average of nations on their attributes over time and whose extension is given by the relationship among the attributes. Social time is part of this space and nations have projections on the social time dimensions dependent on their relative magnitude and change on the attributes correlated with calendar time.

The location of nations in social time and in calendar time are not necessarily the same. Therefore, nations can have a social time distance from each other for identical calendar times and this distance partially measures the different progress of the nations along the social time dimensions.

Since the origin of the space is at the mean values for all nations over time, the social distances between nations at one time period are relative to the attributes of nations through time. This reflects the belief that behavior in its relationship to distances takes place in a context and that the key to understand-

ing the role of this context is the idea of the relativity of behavior and attributes from the point of view of the actor.

The way in which behavior and attributes are linked implies that the time paths of the behavior of one nation to another are a linear transformation of the time paths of their distances, as illustrated in the hypothetical curves of Figure 9. If the framework and theory developed here are valid, then, a knowledge of the distances between nations at some future time should enable the prediction of their behavior.

The variation in the space time parameters by actor implies that the influence of social distances differs by actor. This is due to each nation having unique cultural, institutional, and historical characteristics. Each nation will be influenced by social distances; how they impact on behavior depends on the national character.

Although varying by actor, the social space-time parameters do not vary by time t . This means that to have a knowledge of these parameters for one time period is to know them for T time periods.⁴⁴ These parameters therefore describe a system state -- a particular configuration of relationship stable through time, where T describes the temporal life of this particular system.

Systemic change is therefore a change in relationships through time, where the change is measured by the alteration in the values of the social space-time parameters for the actors in the international system. These parameters, for example, might have been constant for the US, UK, France, and USSR in the period 1920-1938, and quite different in the years 1946-1960. Since 1960, I suspect, the parameters have again undergone a change with the remarkable shift in the character

⁴⁴ See Figure 2 again for a picture of how the T time periods structure attribute space.

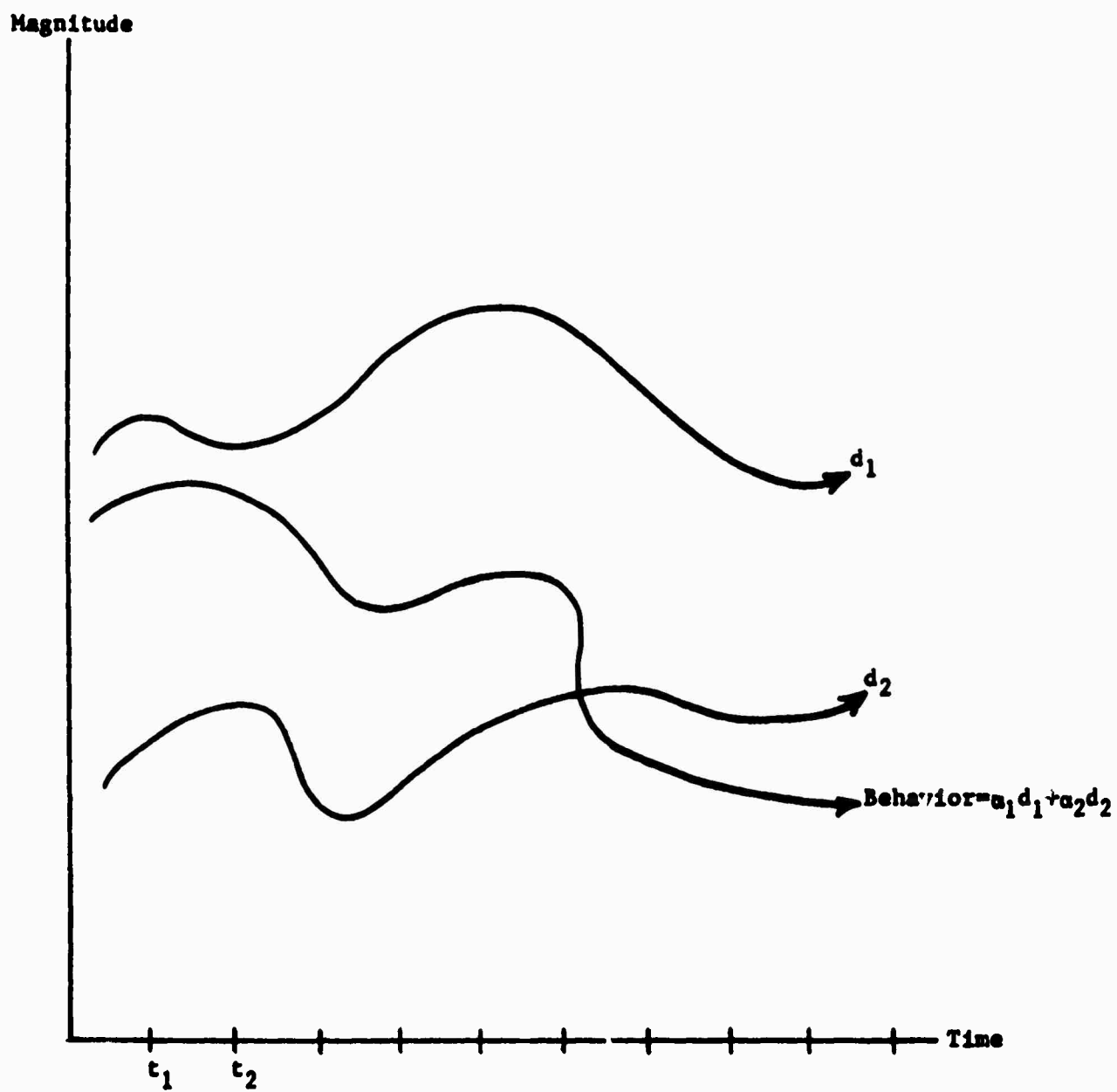


FIGURE 9

of the international system. It is important to note that if we define T as covering only the periods within which the parameters are constant, then with change in system we have also a different origin of social space. Thus, systemic change also entails a change in the perspective of each nation toward others -- a change in the context of behavior.

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13. ABSTRACT			
<p>Time in our physical world is now a fourth dimension. It is considered relative and dependent upon the point of view of the observer. In our social world, time is subjective and also depends on the perspective of the observer.</p> <p>In social science theorizing and empirical analysis, however, time is treated as an absolute continuum along which all events and entities existing at the same time have the same temporal status. This is true, for example, in all theoretical work in IR where the existence of an absolute calendar time is assumed. The purpose of this paper is to help alter the dependence on this singular view of time by incorporating in a field theory of international relations the notions of subjective (social) and multidimensional time.</p> <p>In the representation developed here, time is treated as a set of dimensions which, along with social dimensions, describe the social space of nations. Attributes and behavior of nations have projections on these time dimensions contingent on a nation's change through calendar time. Nations are differently located on the time dimensions in terms of their relative magnitudes on the attributes related to time and their change in time on these attributes.</p> <p>Social time in international relations is then represented as being dependent on the observer nation. In field theory terms, distances (for the same calendar time) between nation actor and object can be computed on the social time dimensions and treated as social forces effecting the behavior of one nation to another.</p>			

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